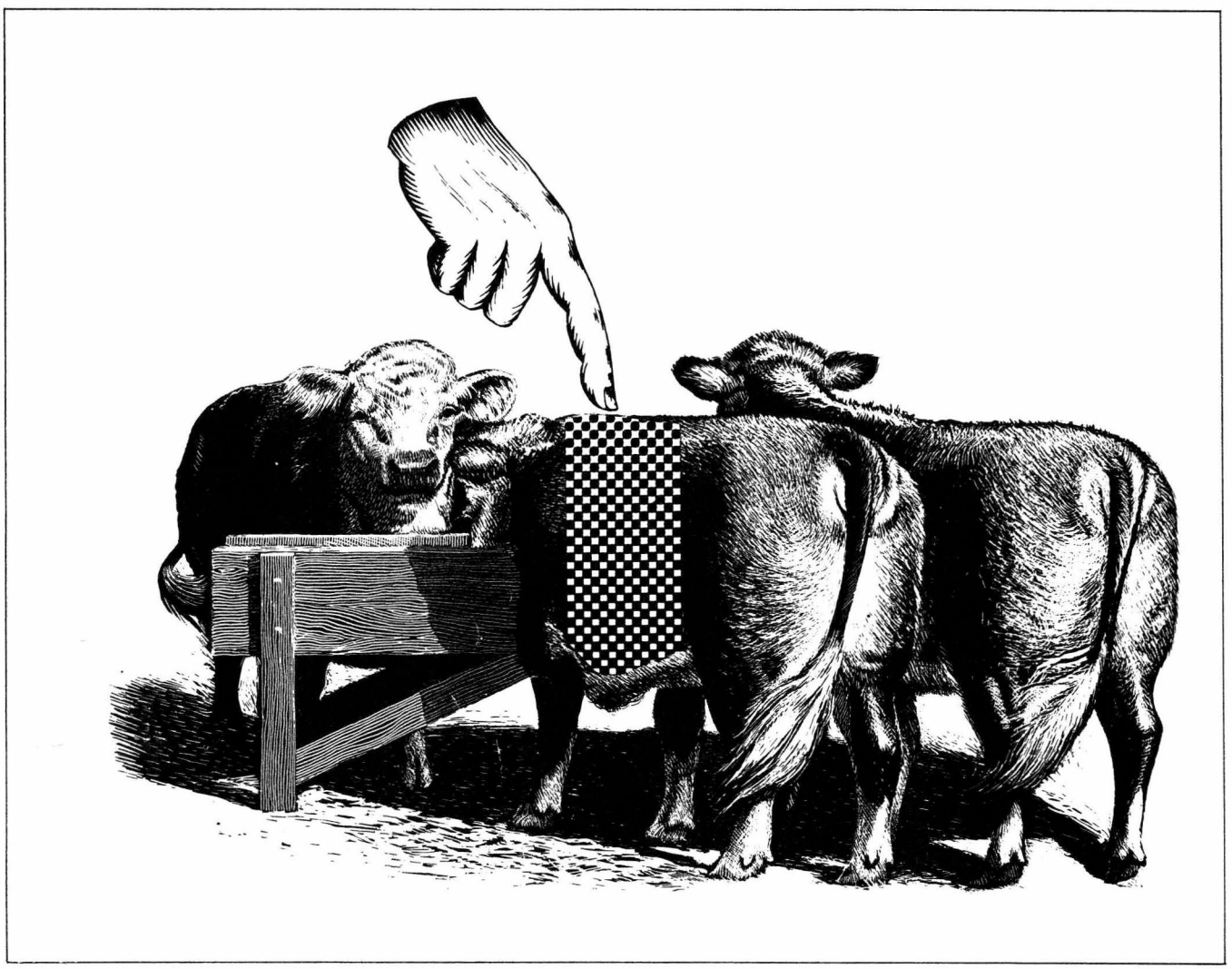
SENSORY EVALUATIONS OF BEEF IN THE HONOLULU MARKET

Linda J. Cox and Peter V. Garrod



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INTRODUCTION

During the past decade, annual per capita consumption of beef in the United States has declined by 21 lb, in carcass weight, from 127.6 lb to 106.6 lb (USDA). If consumption continues to drop and population does not grow, the Hawaii beef industry may find it hard to maintain its current market share. In fact, the only way for the industry to maintain current production levels will be to increase its market share, particularly as exporting beef from Hawaii has not proven economically viable.

To capture a larger share of the local market, Hawaii must produce and market the type of beef customers want, at competitive prices. This means that the beef must have the desired quality attributes and that retailers and consumers must be aware that the beef has these attributes. The question for producers, then, is twofold: first, what type of beef do retailers and consumers want; and second, how can customers know that the Hawaii beef being marketed is the type they want? Maintaining a price that is acceptable to both consumers and producers provides an underlying constraint.

This report deals with the first part of the question. Ideally, information on the desirable attributes of beef would be gained by evaluating actual consumer purchases from a varied selection at a retail meat counter. Because this is a long and costly process, market researchers often use trained taste panels. Such panels can provide much of the information required; they are more cost-effective, and the results are available quickly. Panels were used in the research reported here.

This report summarizes ongoing research. A scientific description of the research and the results will be in a forthcoming publication.

Results are presented here from two experiments designed to investigate differences in quality attributes among Good grade steaks from Mainland (grain-fed) beef, local grain-fed and local forage-fed beef and between Standard grade steaks from grain-fed and forage-fed beef. All these types of fresh meat are available at Hawaii retail meat counters. Forage-fed beef, however, is available only at a few small retail outlets.

Physical attributes in this study were color, marbling, tenderness, and percent cooking weight loss. The color of each raw steak was evaluated by an expert using an eight-point scale, with a higher score indicating a darker steak. The same expert evaluated the marbling of each raw steak on a scale of 0.0 to 10.0, with a higher score indicating more marbling. Tenderness was measured with a Warner-Bratzler shear instrument, which registers the force in pounds per square inch required to shear a one-inch core of cooked steak. Percent cooking loss included both moisture lost through evaporation and fat-drip loss during cooking.

Sensory attributes in the study were flavor intensity, juiciness, tenderness, amount of connective tissue, and overall palatability. The sensory information was obtained by using a trained taste panel of

12 judges. Each panelist received two training sessions; these included instruction in procedures, scales used, and scale semantics, then sampling roast beef and rating the palatability attributes of the samples.

ANALYSIS OF PHYSICAL ATTRIBUTES

For Hawaii-produced Good beef, forage-fed was significantly higher than grain-fed in shear force and marbling and had a darker color. Forage-fed also had significantly more marbling and a darker color than mainland grain-fed. There was no significant difference in cooking loss in the Good beef among the three feeding regimes. Good mainland had a significantly higher shear force and a darker color than Good local grain-fed. Local Standard grain-fed had significantly less marbling and was lighter in color than local forage-fed. There was no significant difference in shear force or cooking loss between the two feeding regimes. Table 1 summarizes the results.

The differences found among animals within grade and feeding regime were expected. Grade specifications are such that a significant range of values can exist within a specific grade. This variation can confound the analysis of the panel data; however, the effect will be minimal if the difference between feeding regimes outweighs the differences among animals. Physical measurements show that in the Good grade animals, the forage-fed steaks differ from both the local and mainland grain-fed steaks.

Table 1. Average objective measures and statistically significant differences among feeding regimes.

	A Grain-fed	B Forage-fed	C Mainland	F[a]	Significant Differences[b]
Good Grade Beef (n=18)[c]					
Cooking Loss	27.72	26.36	29.24	2.81	none
Shear Force	13.79	18.25	17.99	11.94	B>A, C>A
Color	4.17	5.88	4.33	34.94	B>A, B>C, C>A
Marbling	3.32	3.64	3.29	3.83	B>A, B>C
Standard Grade Beef (n=18)					
Cooking Loss	28.42	26.93		3.30	none
Shear Force	16.79	15.46		1.83	none
Color	4.17	5.44		11.56	B>A
Marbling	2.25	2.43		5.29	B>A

[a] F: statistic used to test for significant differences between treatments.

[b] Based on Duncan's New Multiple Range Test, 95% probability level.

[c] Averages computed based on n observations.

ANALYSIS OF SENSORY ATTRIBUTES

Basic statistical analysis of the sensory scores using ANOVA indicated that local grain-fed beef always scored higher than mainland beef, except in flavor. (Appendix A shows the scales used by the panelists.) In terms of tenderness and connective tissue, local grain-fed beef also scored higher than local forage-fed beef. The flavor intensity scores did not differ significantly. Transforming the data so that the resulting distribution was approximately normal resulted in the local grain-fed beef palatability measure becoming significantly different from the measure for forage-fed beef.

An order statistical technique was also applied. It found no significant difference in overall palatability between local grain- and forage-fed and found that both scored higher than mainland. For Standard grade beef, no significant difference between local grain- and forage-fed was found in any of the palatability attributes, regardless of the analysis used. Table 2 and Appendixes B and C summarize the results.

Table 2. Average sensory scores[a] and statistically significant differences among feeding regimes.

	A Grain-fed	B Forage-fed	C Mainland	F[b]	Significant Differences[c]
Good Grade Steaks (n=34)[d]					
Flavor Int.	5.32	5.79	5.23	1.87	none
Juiciness	5.50	4.94	4.21	5.15	A>C
Tenderness	7.03	5.32	5.24	22.98	A>B, A>C
Con'ctv. Tiss.	7.00	5.24	5.76	18.53	A>B, A>C
Overall Pal'ty.	6.00	5.29	4.71	8.36	A>C
Standard Grade Steaks (n=35)					
Flavor Int.	5.14	5.74		2.20	none
Juiciness	4.43	4.34		0.06	none
Tenderness	5.63	5.43		0.39	none
Con'ctv. Tiss.	6.00	5.51		2.18	none
Overall Pal'ty.	5.60	5.26		1.37	none

[a] Untransformed scores.

[b] F: statistic used to test for significant differences between treatments.

[c] Based on Duncan's New Multiple Range Test, 99% probability level.

[d] Averages computed based on n observations.

Analysis of the relationship between the sensory attributes and overall palatability indicated that the latter is a function of tenderness, juiciness, and connective tissue. Further analysis indicated that only an increase in connective tissue decreased overall palatability when the taste test scores of each judge were analyzed separately. This may indicate that not all beef consumers find the same characteristiscs desirable and that panel members did not find "chewy" beef palatable.

Investigation into the relationships between the physical measures and sensory scores showed that flavor intensity increased significantly as the color of the steak darkened and that juiciness was not related to any of the physical measures. The amount of connective tissue had a significant positive relationship with shear force, cooking loss, and color, while tenderness had a significant negative relationship with these variables. Overall palatability had a significant negative relationship with shear force and cooking loss.

Grain-fed Standard grade beef was not rated higher than forage-fed Standard beef. This may indicate that there is no advantage to grain-feeding if the highest grade to be achieved by the carcass is Standard. The Standard forage-fed carcasses, however, were aged longer than the Standard grain-fed carcasses. This was not the case for the Good carcasses, where aging was the same.

Grain-feeding significantly improved the quality of local Good beef, primarily by increasing tenderness and reducing connective tissue. The relatively low ratings of mainland Good beef are hard to explain but may be related to higher cooking losses.

CONCLUSIONS

The fundamental limitation implicit in the experimental data must be emphasized: these results are from a trained taste panel, not from actual beef consumers who have bought the product at market. Therefore, while tentative inferences about palatability can be cautiously made, inferences about actual purchases by consumers are likely to be valid only to the extent that consumers base their purchases on taste. In fact, consumers base their purchases of beef on several factors, of which the attributes measured here are only a small subset. Other important factors include appearance, price, display, and the price of competing meats.

The results do imply, however, that any specifications used by the Hawaii beef industry should take into account both the feeding regimes and the amount of connective tissue. Because panel members found a difference between Good grain- and forage-fed beef, consumers may also be able to tell the differences, making it a mistake to market these two types of beef under the same specification or label. In addition, carcass or animal characteristics associated with connective tissue should be determined so that they can be included in the specifications.

Hawaii grain-fed beef generally scored higher than mainland grain-fed beef. If the attributes measured by the panel correspond to consumer preferences, this implies that local grain-fed beef should be able to compete effectively with imports from the Mainland, at least in terms of palatability.

REFERENCES

Gibbons, J. D. 1971. *Nonparametric statistical inference*. McGraw-Hill, New York.

U. S. Department of Agriculture. 1985. *Livestock and poultry: Outlook and situation report*. Washington, D. C.

APPENDIX A
Sensory Attribute Scale

Flavor Intensity	Juiciness	Tenderness
8 - Extremely intense	8 - Extremely juicy	8 - Extremely tender
7 - Very intense	7 - Very juicy	7 - Very tender
6 - Moderately intense	6 - Moderately juicy	6 - Moderately tender
5 - Slightly intense	5 - Slightly juicy	5 - Slightly tender
4 - Slightly bland	4 - Slightly dry	4 - Slightly tough
3 - Moderately bland	3 - Moderately dry	3 - Moderately tough
2 - Very bland	2 - Very dry	2 - Very tough
1 - Extremely bland	1 - Extremely dry	1 - Extremely tough

Connective Tissue Amount	Overall Palatability
8 - None	8 - Extremely desirable
7 - Practically none	7 - Very desirable
6 - Traces	6 - Moderately desirable
5 - Slight	5 - Slightly desirable
4 - Moderate	4 - Slightly undesirable
3 - Slightly abundant	3 - Moderately undesirable
2 - Moderately abundant	2 - Very undesirable
1 - Abundant	1 - Extremely undesirable

APPENDIX B

Average transformed[a] sensory scores and statistically significant differences among feeding regimes.

	A Grain-fed	B Forage-fed	C Mainland	F[b]	Significant Differences[c]
Good Grade Steaks (n=34)[d]					
Flavor Int.	0.760	0.878	0.745	2.92	none
Juiciness	0.834	0.716	0.581	5.00	A>C*
Tenderness	1.183	0.773	0.741	26.03	A>B, A>C
Con'ctv. Tiss.	1.187	0.775	0.868	19.01	A>B, A>C
Overall Pal'ty.	0.891	0.778	0.651	9.70	A>B, A>C
Standard Grade Steaks (n=35)					
Flavor Int.	0.749	0.863		2.55	none
Juiciness	0.617	0.601		0.06	none
Tenderness	0.601	0.840		0.41	none
Con'ctv. Tiss.	0.928	0.816		2.31	none
Overall Pal'ty.	0.824	0.757		1.18	none

[a] Transformation used is arcsin(score/8).

[b] F: statistic used to test for significant differences between treatments.

[c] Based on Duncan's New Multiple Range Test, an * indicates a significant difference at the 95% level. All other differences noted are significant at the 99% level.

[d] Averages computed based on n observations.

APPENDIX C

Average sensory ranks and statistically significant differences among feeding regimes, based on Friedman's two-way ANOVA.[a]

	A Grain-fed	B Forage-fed	C Mainland	F[b]	Significant Differences[c]
Good Grade Steaks (n=34)[d]					
Flavor Int.	1.81	2.28	1.91	2.15	none
Juiciness	2.25	2.09	1.66	3.36	A>C*
Tenderness	2.69	1.72	1.59	18.77	A>B, A>C
Con'ctv. Tiss.	2.53	1.72	1.75	8.79	A>B, A>C
Overall Pal'ty.	2.41	2.03	1.56	7.37	A>C, B>C*
Standard Grade Steaks (n=35)					
Flavor Int.	1.37	1.63		2.41	none
Juiciness	1.53	1.47		0.11	none
Tenderness	1.54	1.46		0.25	none
Con'ctv. Tiss.	1.60	1.40		1.46	none
Overall Pal'ty.	1.54	1.46		0.25	none

[a] The interval scores for each judge were converted into ranks. In the case of Good beef, each panelist's scores were converted into ranks (1, 2, and 3), with ties being assigned the average rank. The ranks were then entered in a standard ANOVA format where columns were treatments and rows were panelists. Statistical tests are based on R_j, the sum of ranks for treatment j. For large n (n>7), Friedman has shown that standard two-way ANOVA techniques yield valid F statistics (Gibbons).

[b] F: statistic used to test for significant differences between treatments.

[c] Based on Duncan's New Multiple Range Test, an * indicates a significant difference at the 95% level. All other differences noted are significant at the 99% level.

[d] Averages computed based on n observations.

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